

We Claim:

1. A sorting conveyor for transporting objects and unloading objects at one or more unloading stations adjacent the conveyor, said sorting conveyor comprising:

- (a) a conveyor track;
- (b) a train of conveyor carts connected end-to-end; and
- (c) an opposed roller motor assembly for moving said conveyor carts on said conveyor track;
- (d) each of said conveyor carts including: (i) a trailer frame base, including: a roller structure for engaging said conveyor track, a driven member responsive to said opposed roller motor assembly, and a hitch mechanism for connecting each conveyor cart to an adjacent conveyor cart; (ii) a carrying tray for holding the objects; and (iii) a tiltable support apparatus for supporting said carrying tray above said trailer frame base and for allowing tilting of said carrying tray towards at least one side of the conveyor to unload objects into unloading stations on at least one side of the conveyor.

2. The apparatus according to Claim 1, wherein said tiltable support apparatus includes: an upper support structure joined to said carrying tray, a lower support structure joined to said trailer frame base, and a pivot structure connecting the upper support structure to the lower support structure along a pivot axis; and a tilting mechanism for tilting said carrying tray on said tiltable support apparatus to thereby unload objects into

one of the unloading stations adjacent the conveyor,  
wherein said tilting mechanism includes: a pair of  
actuating arms attached to said carrying tray on opposite  
sides of said tiltable support apparatus; and a pull-down  
5 mechanism associated with each unloading station for  
selectively pulling down one of said actuating arms so as  
to pull one side of said carrying tray downwardly into a  
tilted position; wherein each of said actuator arms  
includes a cam follower on a lower end of said actuator  
10 arm, and wherein said pull-down mechanism includes a  
descending ramp adjacent said conveyor track, a laterally  
pivoting switch for directing the cam follower of a  
selected actuator arm into said descending ramp and an  
actuator connected to said laterally pivoting switch for  
15 opening said laterally pivoting switch so as to capture a  
selected cam follower and direct the cam follower into  
the descending ramp and for closing said laterally  
pivoting switch after capture of the cam follower and  
wherein said tilting mechanism further comprises a  
20 locking structure for locking said carrying tray in the  
tilted position upon pulling down of one of said  
actuating arms, and for locking said carrying tray in the  
upright position upon pushing up of said actuating arm.

25 3. The apparatus according to Claim 2, wherein  
said actuating arms are each pivotally attached to said  
carrying tray beneath said carrying tray.

30 4. The apparatus according to Claim 3, wherein the  
pivot axes of said actuating arms are parallel to the  
pivot axis of said tiltable support apparatus.

35 5. The apparatus according to Claim 3, wherein  
said actuating arms are pivotally attached to said upper  
support structure of said tiltable support apparatus.

6. The apparatus according to Claim 3, wherein the pivot axis of said pivot structure lies in a vertical plane parallel to the conveyor line of travel, and wherein said actuating arms remain substantially parallel to the vertical plane parallel to the conveyor line of travel during pulling down and pushing up of said actuating arms to tilt said carrier tray.

7. The apparatus according to Claim 2, wherein said locking structure includes:

- (a) a pair of laterally extending locking flanges on opposite sides of said tiltable support apparatus;
- (b) a pair of locking blocks mounted to inner surfaces of said actuating arms, each locking block having locking channels that receive said locking flanges; and
- (c) a biasing member attached to both actuating arms for biasing said actuating arms towards each other so as to urge said each of said locking flanges into one of said locking channels.

8. The apparatus according to Claim 7, wherein each locking block includes a locking channel associated with the tilted position of said carrying tray, and wherein each locking block includes a locking channel associated with the upright position of said carrying tray.

9. The apparatus according to Claim 8, wherein each said locking flange includes a roller mounted to an outer edge thereof.

10. The apparatus according to Claim 9, wherein each said locking block includes a cammed section between

said locking channels over which said rollers on the outer edges of said locking flanges roll.

11. The apparatus according to Claim 1, wherein  
5 said conveyor track comprises two parallel rails.

12. The apparatus according to Claim 11, wherein  
said trailer frame base includes a longitudinal base  
member that extends between the two parallel rails  
10 parallel to the conveyor line of travel.

13. The apparatus according to Claim 12, wherein  
said roller structure comprises two laterally extending  
cam follower mechanisms, one cam follower mechanism  
15 riding on each conveyor track rail.

14. The apparatus according to Claim 11, wherein  
each said cam follower mechanism includes an axle caster  
that holds a cam follower, each said axle caster  
20 including two forks, a bearing bore disposed at a  
junction between said two forks, and at least one flange  
bearing seated within said bearing bore and disposed  
around an axle shaft extending from said roller  
structure.

15. The apparatus according to Claim 14, wherein  
said cam follower is held in place in said axle caster by  
a nut and bolt extending through said cam follower and  
both of said forks, wherein said axle caster also  
30 includes an opening on one side of said bearing bore that  
communicates with a space between said two forks, and  
wherein said at least one flange bearing is secured  
within said bearing bore by tightening said nut and bolt  
so as to inwardly flex said two forks towards each other,  
35 thereby slightly closing said opening and distorting said  
bearing bore.

16. The apparatus according to Claim 13, wherein  
each conveyor track rail is supported only on an outside  
edge, and wherein each cam follower mechanism comprises  
5 three cam followers.

17. The apparatus according to Claim 16, wherein  
each cam follower mechanism includes an upper cam  
follower for riding on a top edge of a track rail, a  
10 middle cam follower for riding on an inside edge of the  
track rail, and a lower wheel for riding on a bottom edge  
of the track rail.

18. The apparatus according to Claim 13, wherein  
15 the cam follower mechanisms are attached to a forward end  
of said longitudinal base member.

19. The apparatus according to Claim 1, wherein the  
driven member of said trailer frame base comprises a fin  
20 moved in the conveyor line of travel by said opposed  
roller motor assembly.

20. The apparatus according to Claim 19, wherein  
said opposed roller motor assembly and said metal fin are  
25 both vertically oriented beneath said trailer frame base.

21. The apparatus according to Claim 20, wherein  
said metal fin is generally parallelogram-shaped with  
30 rearwardly angled front and rear edges.

22. The apparatus according to Claim 19, wherein  
said opposed roller motor assembly comprises at least one  
drive roller and at least one opposing surface for off-  
35 setting the mechanical load of said drive roller.

23. The apparatus according to Claim 1, wherein said hitch mechanism comprises a front hitch on a front end of said trailer frame base, a rear hitch on a rear end of said trailer frame base, and a hitch connector for  
5 connecting the front hitch of one conveyor cart to the rear hitch of an adjacent conveyor cart.

24. The apparatus according to Claim 23, wherein the front hitch is disposed overtop of the rear hitch.

25. The apparatus according to Claim 1, wherein said trailer frame base comprises an auxiliary cart connector for connecting each conveyor cart to an adjacent conveyor cart to prevent adjacent conveyor carts  
15 from separating upon failure of said hitch mechanism.

26. The apparatus according to Claim 25, wherein said auxiliary cart connector comprises an electrically conductive cable connected at one end to said trailer frame base and at another end to a trailer frame base of  
20 an adjacent conveyor cart.

27. The apparatus according to Claim 1, wherein said sorting conveyor includes at least one single-axis conveyor cart that comprises a tiltable support apparatus having a horizontal pivot axis that is disposed generally  
25 parallel to the conveyor line of travel.

28. The apparatus according to Claim 2, wherein said actuator includes: (a) an actuator arm having a first end and a second end, said pivot switch being connected to said first end of said actuator arm; and  
30 (b) a bi-directional actuator attached to said actuator arm second end, whereby said rotary actuator assembly is operable to rotate said laterally pivoting switch to  
35

engage said cam follower and direct said cam follower of a selected actuator arm into said descending ramp.

29. The apparatus according to Claim 28, wherein  
5 said bi-directional actuator includes a coil spring attached to said actuator arm second end to rotate said pivot switch to said closed position.

30. The apparatus according to Claim 28, further  
10 including an outer clevis coaxially aligned around said actuator arm to protect said actuator arm.

31. The apparatus according to Claim 30, wherein  
15 said actuator arm includes a roll pin extending substantially perpendicular from said actuator arm for connecting said actuator arm to said pivot switch and wherein said outer clevis includes an aperture, said aperture being sized to allow said roll pin to extend outward therefrom into said pivot switch.

32. The apparatus according to Claim 28, wherein  
20 said bi-directional actuator is a brushless torque actuator.

33. The apparatus according to Claim 32, wherein  
25 said brushless torque actuator is mounted within a heat sink.

34. An opposed roller motor assembly for a sorting  
30 conveyor for transporting objects and unloading objects at one or more unloading stations adjacent the conveyor, said sorting conveyor including: a conveyor track; and a train of conveyor carts connected end-to-end, each of said conveyor carts having: (i) a trailer frame base,  
35 including: a roller structure for engaging said conveyor track, an extended fin driven member responsive to said

opposed roller motor assembly, and a hitch mechanism for  
connecting each conveyor cart to an adjacent conveyor  
cart; (ii) carrying means for holding the objects; and  
(iii) unloading means for unloading the objects into  
5 unloading stations on at least one side of the conveyor,  
said apparatus comprising:

- (a) a motor;
- (b) a support frame attached to said conveyor  
track for supporting said motor;
- 10 (c) at least one cantilevered, drive roller  
connected to said motor and adjacent to  
one surface of said extended fin driven  
member; and
- 15 (d) an opposing surface adjacent to the other  
surface of said extended fin driven member  
for off-setting the mechanical load of  
said drive roller.

35. The apparatus according to Claim 34, wherein  
20 said support frame includes a base attached to said  
conveyor track and an adjustable sub-frame connected to  
said base for supporting said drive roller.

36. The apparatus according to Claim 35, wherein  
25 said adjustable sub-frame includes a first shaft  
pivotally connected to said base by a dowel passing  
through the mid-section of said first shaft and a chamber  
linkage connected between one end of said first shaft and  
said base.

37. The apparatus according to Claim 36, wherein  
30 said adjustable sub-frame further includes a pivot block  
assembly attached to the other end of said first shaft  
and a second shaft attached at one end to said pivot  
35 block and at the other end to said drive roller.



38. The apparatus according to Claim 37, wherein said pivot block assembly further includes a compression linkage connected between said pivot block and said base.

5 39. The apparatus according to Claim 37, wherein said pivot block assembly further includes a plurality of locking rings between each end of each shaft and said pivot block for centering the ends of said shafts within said pivot block.

10 40. The apparatus according to Claim 34, wherein said drive roller assembly includes a generally cylindrical roller having an outer elastomeric surface for frictionally engaging said extended fin.

15 41. The apparatus according to Claim 40, wherein said elastomeric surface is a polyurethane.

20 42. The apparatus according to Claim 41, wherein said polyurethane is a thermosetting-type urethane.

25 43. The apparatus according to Claim 41, wherein said polyurethane has a Shore A hardness between about 70 and 80.

30 44. The apparatus according to Claim 34, wherein said motor assembly includes a rotary motor and a drive belt connecting said motor and said drive roller, wherein said drive roller includes a frictional surface for receiving said drive belt.

35 45. The apparatus according to Claim 34, wherein said opposing surface adjacent to the other surface of said extended fin driven member for off-setting the mechanical load of said drive roller is a second drive roller assembly.

46. The apparatus according to Claim 34, wherein said second drive roller assembly further includes a second motor assembly.

5

47. A sorting conveyor for transporting objects and unloading objects at one or more unloading stations adjacent the conveyor, said sorting conveyor comprising:

- 10 (a) a conveyor track;
- (b) a train of conveyor carts connected end-to-end; and
- 15 (c) an opposed roller motor assembly for moving said conveyor carts on said conveyor track, said roller motor assembly including: (i) a motor; (ii) a support frame attached to said conveyor track for supporting said motor; (iii) at least one cantilevered, drive roller connected to said motor and adjacent to one surface of
- 20 *RPS.* ~~a said~~ <sup>an</sup> extended fin driven member; and (iv) an opposing surface adjacent to the other surface of said extended fin driven member for off-setting the mechanical load of said drive roller;
- 25 (d) each of said conveyor carts including: (i) a trailer frame base, including: a roller structure for engaging said conveyor track, a driven member responsive to said opposed roller motor assembly, and a hitch mechanism for connecting each conveyor
- 30 cart to an adjacent conveyor cart; (ii) a carrying tray for holding the objects; and (iii) a tiltable support apparatus for supporting said carrying tray above said trailer frame base and for allowing
- 35 tilting of said carrying tray towards at

least one side of the conveyor to unload  
objects into unloading stations on at  
least one side of the conveyor and wherein  
said tilting mechanism includes: an upper  
support structure joined to said carrying  
tray, a lower support structure joined to  
said trailer frame base, and a pivot  
structure connecting the upper support  
structure to the lower support structure  
along a pivot axis; and a tilting  
mechanism for tilting said carrying tray  
on said tiltable support apparatus to  
thereby unload objects into one of the  
unloading stations adjacent the conveyor,  
wherein said tilting mechanism includes: a  
pair of actuating arms attached to said  
carrying tray on opposite sides of said  
tiltable support apparatus; and a pull-  
down mechanism associated with each  
unloading station for selectively pulling  
down one of said actuating arms so as to  
pull one side of said carrying tray  
downwardly into a tilted position; wherein  
each of said actuator arms includes a cam  
follower on a lower end of said actuator  
arm, and wherein said pull-down mechanism  
includes a descending ramp adjacent said  
conveyor track, a laterally pivoting  
switch for directing the cam follower of a  
selected actuator arm into said descending  
ramp and an actuator connected to said  
laterally pivoting switch for opening said  
laterally pivoting switch so as to capture  
a selected cam follower and direct the cam  
follower into the descending ramp and for  
closing said laterally pivoting switch

46

after capture of the cam follower and wherein said tilting mechanism further comprises a locking structure for locking said carrying tray in the tilted position upon pulling down of one of said actuating arms, and for locking said carrying tray in the upright position upon pushing up of said actuating arm.

48. The apparatus according to Claim 47, wherein said actuating arms are each pivotally attached to said carrying tray beneath said carrying tray.

49. The apparatus according to Claim 48, wherein the pivot axes of said actuating arms are parallel to the pivot axis of said tiltable support apparatus.

50. The apparatus according to Claim 48, wherein said actuating arms are pivotally attached to said upper support structure of said tiltable support apparatus.

51. The apparatus according to Claim 48, wherein the pivot axis of said pivot structure lies in a vertical plane parallel to the conveyor line of travel, and wherein said actuating arms remain substantially parallel to the vertical plane parallel to the conveyor line of travel during pulling down and pushing up of said actuating arms to tilt said carrier tray.

52. The apparatus according to Claim 47, wherein said locking structure includes:

- (a) a pair of laterally extending locking flanges on opposite sides of said tiltable support apparatus;
- (b) a pair of locking blocks mounted to inner surfaces of said actuating arms, each

47

- locking block having locking channels that receive said locking flanges; and
- (c) a biasing member attached to both actuating arms for biasing said actuating arms towards each other so as to urge said each of said locking flanges into one of said locking channels.

53. The apparatus according to Claim 52, wherein each locking block includes a locking channel associated with the tilted position of said carrying tray, and wherein each locking block includes a locking channel associated with the upright position of said carrying tray.

54. The apparatus according to Claim 53, wherein each said locking flange includes a roller mounted to an outer edge thereof.

55. The apparatus according to Claim 54, wherein each said locking block includes a cammed section between said locking channels over which said rollers on the outer edges of said locking flanges roll.

56. The apparatus according to Claim 47, wherein said conveyor track comprises two parallel rails.

57. The apparatus according to Claim 56, wherein said trailer frame base includes a longitudinal base member that extends between the two parallel rails parallel to the conveyor line of travel.

58. The apparatus according to Claim 57, wherein said roller structure comprises two laterally extending cam follower mechanisms, one cam follower mechanism riding on each conveyor track rail.

59. The apparatus according to Claim 56, wherein each said cam follower mechanism includes an axle caster that holds a cam follower, each said axle caster including two forks, a bearing bore disposed at a juncture between said two forks, and at least one flange bearing seated within said bearing bore and disposed around an axle shaft extending from said roller structure.

60. The apparatus according to Claim 59, wherein said cam follower is held in place in said axle caster by a nut and bolt extending through said cam follower and both of said forks, wherein said axle caster also includes an opening on one side of said bearing bore that communicates with a space between said two forks, and wherein said at least one flange bearing is secured within said bearing bore by tightening said nut and bolt so as to inwardly flex said two forks towards each other, thereby slightly closing said opening and distorting said bearing bore.

61. The apparatus according to Claim 58, wherein each conveyor track rail is supported only on an outside edge, and wherein each cam follower mechanism comprises three cam followers.

62. The apparatus according to Claim 61, wherein each cam follower mechanism includes an upper cam follower for riding on a top edge of a track rail, a middle cam follower for riding on an inside edge of the track rail, and a lower wheel for riding on a bottom edge of the track rail.

63. The apparatus according to Claim 58, wherein the cam follower mechanisms are attached to a forward end of said longitudinal base member.

5           64. The apparatus according to Claim 47, wherein the driven member of said trailer frame base comprises a fin moved in the conveyor line of travel by said opposed roller motor assembly.

10           65. The apparatus according to Claim 64, wherein said opposed roller motor assembly and said metal fin are both vertically oriented beneath said trailer frame base.

15           66. The apparatus according to Claim 65, wherein said metal fin is generally parallelogram-shaped with rearwardly angled front and rear edges.

20           67. The apparatus according to Claim 64, wherein said opposed roller motor assembly comprises at least one drive roller and at least one opposing surface for offsetting the mechanical load of said drive roller.

25           68. The apparatus according to Claim 47, wherein said hitch mechanism comprises a front hitch on a front end of said trailer frame base, a rear hitch on a rear end of said trailer frame base, and a hitch connector for connecting the front hitch of one conveyor cart to the rear hitch of an adjacent conveyor cart.

30           69. The apparatus according to Claim 68, wherein the front hitch is disposed overtop of the rear hitch.

35           70. The apparatus according to Claim 47, wherein said trailer frame base comprises an auxiliary cart connector for connecting each conveyor cart to an

adjacent conveyor cart to prevent adjacent conveyor carts from separating upon failure of said hitch mechanism.

5 71. The apparatus according to Claim 70, wherein said auxiliary cart connector comprises an electrically conductive cable connected at one end to said trailer frame base and at another end to a trailer frame base of an adjacent conveyor cart.

10 72. The apparatus according to Claim 47, wherein said sorting conveyor includes at least one single-axis conveyor cart that comprises a tiltable support apparatus having a horizontal pivot axis that is disposed generally parallel to the conveyor line of travel.

15 73. The apparatus according to Claim 47, wherein said actuator includes: (a) an actuator arm having a first end and a second end, said pivot switch being connected to said first end of said actuator arm; and  
20 (b) a bi-directional actuator attached to said actuator arm second end, whereby said rotary actuator assembly is operable to rotate said laterally pivoting switch to engage said cam follower and direct said cam follower of a selected actuator arm into said descending ramp.

25 74. The apparatus according to Claim 73, wherein said bi-directional actuator includes a coil spring attached to said actuator arm second end to rotate said pivot switch to said closed position.

30 75. The apparatus according to Claim 73, further including an outer clevis coaxially aligned around said actuator arm to protect said actuator arm.

35 76. The apparatus according to Claim 75, wherein said actuator arm includes a roll pin extending



substantially perpendicular from said actuator arm for  
connecting said actuator arm to said pivot switch and  
wherein said outer clevis includes an aperture, said  
aperture being sized to allow said roll pin to extend  
outward therefrom into said pivot switch.

77. The apparatus according to Claim 73, wherein  
said bi-directional actuator is a brushless torque  
actuator.

78. The apparatus according to Claim 77, wherein  
said brushless torque actuator is mounted within a heat  
sink.

79. The apparatus according to Claim 47, wherein  
said support frame includes a base attached to said  
conveyor track and an adjustable sub-frame connected to  
said base for supporting said drive roller.

80. The apparatus according to Claim 79, wherein  
said adjustable sub-frame includes a first shaft  
pivotally connected to said base by a dowel passing  
through the mid-section of said first shaft and a chamber  
linkage connected between one end of said first shaft and  
said base.

81. The apparatus according to Claim 80, wherein  
said adjustable sub-frame further includes a pivot block  
assembly attached to the other end of said first shaft  
and a second shaft attached at one end to said pivot  
block and at the other end to said drive roller.

82. The apparatus according to Claim 81, wherein  
said pivot block assembly further includes a compression  
linkage connected between said pivot block and said base.

83. The apparatus according to Claim 81, wherein  
said pivot block assembly further includes a plurality of  
locking rings between each end of each shaft and said  
pivot block for centering the ends of said shafts within  
said pivot block.

84. The apparatus according to Claim 47, wherein  
said drive roller assembly includes a generally  
cylindrical roller having an outer elastomeric surface  
for frictionally engaging said extended fin.

85. The apparatus according to Claim 84, wherein  
said elastomeric surface is a polyurethane.

86. The apparatus according to Claim 85, wherein  
said polyurethane is a thermosetting-type urethane.

87. The apparatus according to Claim 85, wherein  
said polyurethane has a Shore A hardness between about 70  
and 80.

88. The apparatus according to Claim 47, wherein  
said motor assembly includes a rotary motor and a drive  
belt connecting said motor and said drive roller, wherein  
said drive roller includes a frictional surface for  
receiving said drive belt.

89. The apparatus according to Claim 47, wherein  
said opposing surface adjacent to the other surface of  
said extended fin driven member for off-setting the  
mechanical load of said drive roller is a second drive  
roller assembly.

90. The apparatus according to Claim 47, wherein  
said second drive roller assembly further includes a  
second motor assembly.